

Safety and Effectiveness of an In-Hospital Screening Station for Coronavirus Disease 2019 in Response to the Massive Community Outbreak

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Purpose: To evaluate the results of operating an in-hospital coronavirus disease 2019 screening station on an outpatient basis and to identify the effectiveness and necessity of such a screening station.

Patients and Methods: This cross-sectional study included 1345 individuals who were tested for COVID-19 using real-time reverse transcription polymerase chain reaction (RT-PCR) at an in-hospital screening station on an outpatient basis. The subjects were healthcare workers (HCWs) with suspected COVID-19 symptoms or exposure to patients with confirmed COVID-19, caregivers at the hospital for complete enumeration, and patients who were scheduled to be admitted to a nonrestricted area in the hospital or to visit for outpatient treatment, but had suspected COVID-19 symptoms. The subjects were divided and compared as follows: HCW versus non-HCW groups and RT-PCR positive versus negative groups.

Results: A total of 140 had symptoms, 291 wanted to be tested, and 664 were asymptomatic but were screened. Seven subjects had positive results for COVID-19. Compared with the non-HCWs, the HCWs were younger and had a lower rate of underlying medical conditions. In addition, there were more women, individuals with exposure to confirmed cases, and individuals with symptoms or those who just wanted to be tested. The frequency of all symptoms was high among the HCWs. The results of the logistic regression analysis showed that the HCWs were significantly associated with the presence of symptoms, having an odds ratio of 23.317 (confidence interval, 15.142–35.907L; $P < 0.001$). The positive group had a high rate of exposure to patients with confirmed COVID-19 and had more subjects with symptoms or those who wanted to be tested.

Conclusion: In-hospital screening stations are a relatively safe way to protect and support HCWs and to reduce and manage the spread of infection within the hospital effectively during an outbreak in the community.

Keywords: coronavirus disease 2019, healthcare workers, nocebo effect, hospital infection, screening

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Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), initially identified in Wuhan, China in December 2019, spread rapidly around the world.¹ On March 11, 2020, the World Health Organization (WHO) declared a coronavirus disease 2019 (COVID-19) pandemic.² This declaration of a pandemic marked the third time since the establishment of the WHO in 1948, with the preceding pandemics being the Hong Kong influenza in 1968 and the 2009 swine flu pandemic.

A pandemic is a situation in which certain infectious diseases spread rapidly across a large region of more than two continents, significantly increasing morbidity and mortality and triggering serious economic, social, and political crises.³ Between 2011 and 2018, there have been 1483 epidemics and pandemics, both large and small, in 172 countries around the world, facing the era of a new epidemic that becomes more frequent and difficult to manage.⁴

Healthcare workers (HCW) are at the frontline of response to any pandemic. HCWs include not only doctors and nurses, but also nursing assistants, imaging technicians, emergency medical personnel, and medical waste handlers who are not directly involved in patient care, but are potentially exposed to infectious agents from patients and other HCWs.⁵ Because HCWs are on the front lines, they are not only at a high risk of exposure during the course of treatment, but also at increased risk of infection owing to a heavy workload and psychological stress. In fact, 29% of all confirmed COVID-19 patients in China, 9.1% in Italy, and 15.5% in Spain were HCWs.⁶⁻⁸ Infected HCWs interact with uninfected patients, colleagues, and families, continuously increasing the risk of infection, and their quarantine and treatment can create staffing issues and affect the healthcare system. Therefore, to prevent the spread of the virus within the hospital, it is necessary to quickly determine whether or not HCWs with mild symptoms or asymptomatic HCWs who have been exposed to a confirmed patient are infected. If an infected individual with COVID-19 enters the inpatient wards without preadmission screening, HCWs and other patients or caregivers are exposed to infections.

Although healthcare professionals struggle on the frontlines of response to infectious diseases with a sense of commitment to their jobs for patients, most of them experience psychological distress owing to an increased workload, personal protection, and fear of family infection. Previous studies have shown that 81.2% of HCWs in tertiary hospitals experienced fear and anxiety, and that 67.9% experienced depression in the early stages of SARS in 2003.⁹ Despite the increased risk of COVID-19 exposure and psychological anxiety, most screening stations are outside hospitals, which are less accessible to HCWs. On the other hand, the results of operating in-hospital screening stations have not been reported so far.

The largest outbreak of COVID-19 outside China was the first in South Korea's southeastern city of Daegu, with a population of 242.9 million. After the first patient with

confirmed COVID-19 was announced on February 18, 2020, the number of confirmed COVID-19 patients increased rapidly, with more than 5000 on March 7. By June 16, there were 6894 confirmed cases (56.72% of the total) and 189 deaths (67.99%) reported.¹⁰

Therefore, the present study targeted the COVID-19 screening clinics for patients who were scheduled to be hospitalized as well as other outpatients who did not go through an external screening clinic at the time when the number of COVID-19 patients in Daegu and surrounding areas increased rapidly. Beginning on February 21, 2020, the in-hospital screening station for COVID-19 operating in Daegu's tertiary hospital was observed to determine its safety and effectiveness, as well as the characteristics of the visitors.

Patients and Methods

Study Design and Participants

This study is a cross-sectional study including 1345 individuals who were tested for COVID-19 using real-time reverse transcription polymerase chain reaction (RT-PCR) at the in-hospital screening station for COVID-19, operating on an outpatient basis at Kyungpook National University Hospital in Daegu, South Korea between February 21, 2020 and April 10, 2020.

This study was conducted by a retrospective chart review, which included the real-time RT-PCR test results of the study participants, as well as their age, sex, whether they are HCWs (ie, hospital staff, such as doctors, nurses, nursing assistants, radiologists, clinical pathologists, etc.), clinical symptoms and duration, reason for visit, whether they had been exposed to COVID-19, the timing of exposure, underlying diseases, and medication. The participants included: (1) HCWs employed by Kyungpook National University Hospital, including medical staff with one or more suspected symptom of COVID-19 (fever, cough, rhinorrhea, sputum, febrile sense, cold, muscle pain, headache, nausea, diarrhea, etc.); (2) HCWs at the Kyungpook National University Hospital who want to return to work after self-isolation resulting from exposure to confirmed COVID-19 patients; (3) HCWs including medical staff who returned to their previous work after taking care of confirmed COVID-19 patients; (4) HCWs at Kyungpook National University Hospital who were on duty according to the measures of the infection control office at the hospital because they had been exposed to confirmed COVID-19 patients, but are not at high risk of infection;

(5) patients scheduled to be admitted to a nonrestricted area of the hospital for invasive procedures such as surgery; (6) caregivers in the hospital who perform screening tests in accordance with complete enumeration; and (7) patients who passed the fever check at the hospital entrance and visited a general outpatient department and who are considered to require screening tests for COVID-19 by a doctor and referred to the in-hospital screening station. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of Kyungpook National University Hospital (IRB protocol no. KNUH 2020-04-050). This IRB waived the need for consent. Confidentiality of the information was assured, and privacy of the study subjects was maintained.

In-Hospital Screening Station

During the study period, all visitors to the hospital, including HCWs, were permitted to enter the hospital after a fever check at a restricted entrance. Patients with a fever greater than 37.5°C or who had noticeable suspected symptoms of COVID-19 were taken to a screening station located outside the hospital. The in-hospital screening station for use on an outpatient basis was constructed a certain distance from the general ward, with access restricted to general patients and HCWs. All individuals visiting the in-hospital screening station had their body temperature measured at the time of the visit, and any symptoms, duration, and underlying conditions, exposure to COVID-19, exposure time, healthcare employment status, and the reason for the visit were recorded. The in-hospital screening station had negative pressure rooms, COVID-19 RT-PCR diagnostic laboratories (Bio-Rad CFX96; Bio-Rad Laboratories, Inc., Hercules, CA), and a reception area adjacent to the same restricted area, minimizing distance of movement and time of stay for the visitors and test samples. Visitors made appointments to visit the in-hospital screening station in advance by phone, and appointments were scheduled to maintain appropriate time and a distance of more than 2 meters between the visitors. If necessary, a separate entrance was secured so visitors could leave the hospital directly, minimizing the distance and risk of coming in contact with others in the hospital (Figure 1). In the examining room, a screening test was performed by a skilled specialist wearing personal protective equipment (PPE), including full body protective clothing, goggles, N95 masks, gloves, and overshoes.¹¹ Each sample was collected from the nasopharynx and

oropharynx with ≥ 2 cotton swabs. The collected samples were immediately sent to the diagnostic laboratory. In case of a delay in transfer to the diagnostic laboratory, samples were refrigerated at 4°C to 8°C and subjected to RT-PCR within 1 hour of collection at the latest.¹² The individual was notified by text message if the test result was negative. For positive results, the infection control office immediately notified the local public health center for follow-up.

RT-PCR for COVID-19

SARS-CoV-2, which is a positive-stranded ribonucleic acid (RNA) virus, encodes the RNA-dependent RNA polymerase (RdRP) and four structural proteins, including the spike surface glycoprotein (S), small envelope protein (E), matrix protein (M), and nucleocapsid protein (N).¹³ Nucleic acid tests are the primary method of diagnosing COVID-19. Because it is sensitive and specific, real-time RT-PCR was used for the diagnosis of COVID-19, which was recommended by the Korea Disease Control and Prevention Agency and the WHO.^{14,15} ORF1ab (RdRp), E, N, and S genes are the main targets of RT-PCR to identify SARS-CoV-2. There are various protocols of real-time RT-PCRs in accordance with differences in gene regions for COVID-19 diagnosis around the world. In this study, the Allplex™ 2019-nCoV assay (Seegene Inc., Seoul, South Korea) was used for the detection of SARS-CoV-2, which received emergency use authorization by the United States Food and Drug Administration.^{14,16} This assay was performed to target three genes, namely the RdRP gene in the open reading frame ORF1ab region, the E gene, and the N gene, and showed improved specificity compared with other protocols.¹⁴ When all three genes (ie, E, N, and RdRP) were detected, the result was regarded as positive and confirmed as infection of SARS-CoV-2. When all were not detected, the result was regarded as negative, and others were reported as equivocal. The test was performed using the CFX96 Real-Time PCR Detection System (Bio-Rad Laboratories, Inc.).¹⁷

Statistical Analysis

Continuous variables are presented as means \pm standard deviation, and categorical variables are presented as numbers (%). The participants were divided into HCWs and non-HCWs to compare the general characteristics and RT-PCR results and to analyze the groups by date of visit. Moreover, the RT-PCR positive and negative groups were divided to compare the general characteristics. In the case of contact with confirmed COVID-19 patients, the contact was defined

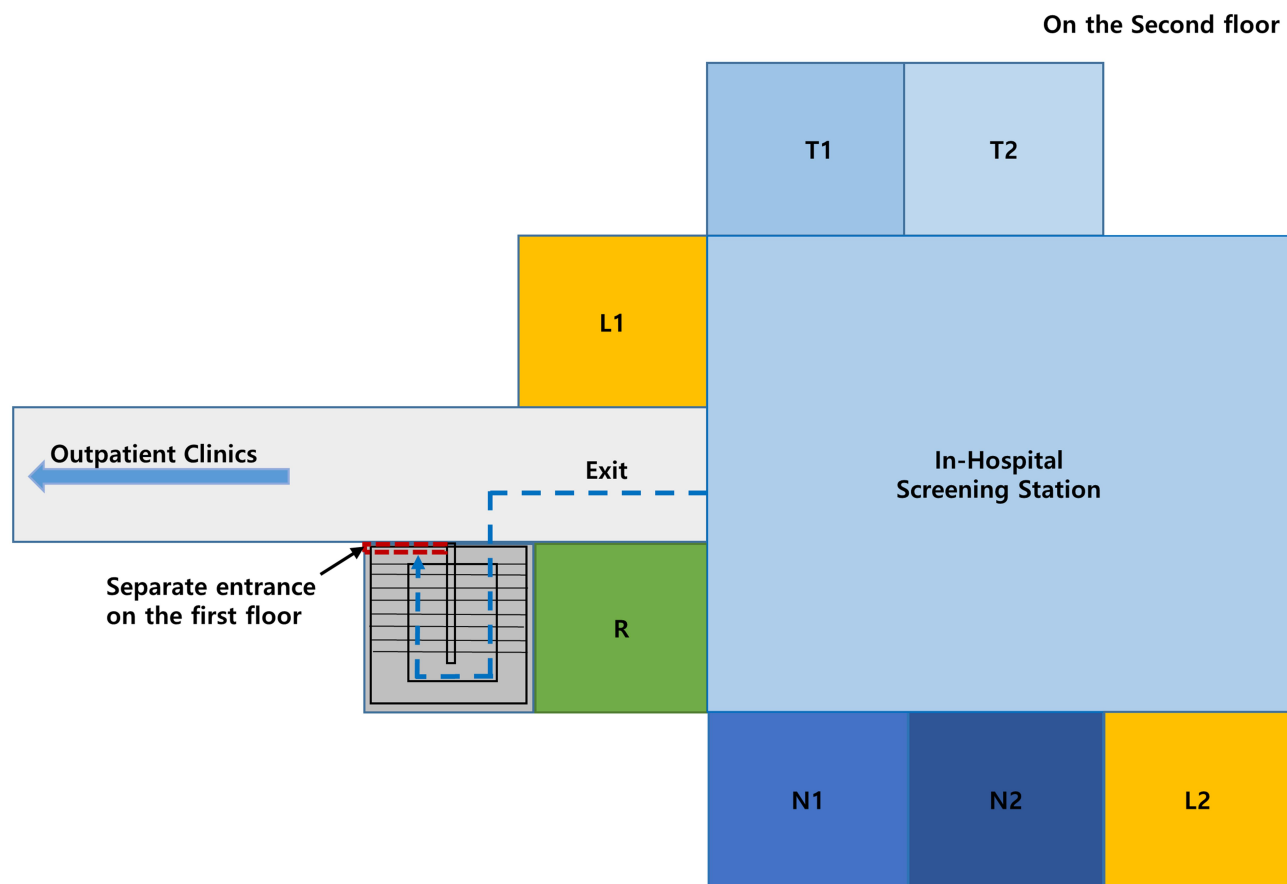


Figure 1 Illustration of in-hospital COVID-19 screening station.

Abbreviations: L1 and L2, laboratories; N1 and N2, negative pressure rooms; R, reception; T1 and T2, toilets.

as no exposure only when the individual was fully equipped with PPE. The chi-square test, *t*-test, Fisher's exact test, and Mann–Whitney *U*-test were used to compare the two groups. In addition, the presence and absence of symptoms and relationship with other variables were examined using the Enter method of a logistic regression model. The purpose of the examination was largely classified as follows: (1) being symptomatic: HCWs with symptoms suspected of COVID-19, including fever, cough, sore throat, and diarrhea, etc., as well as patients who visited a general outpatient department and were referred to the in-hospital screening station by a doctor because of the need for COVID-19 screening; (2) wanting to be tested: HCWs who wanted to be tested because they had been exposed to a confirmed COVID-19 patient during work or outside the hospital but who were still on duty because it was a low-risk exposure; (3) screening test: patients who were scheduled to be admitted to a nonrestricted area for surgery or medication, new employees, and hospital caregivers who needed to be tested for complete enumeration. All statistical analyses were

performed using IBM SPSS statistics 25.0 (IBM Corp., Armonk, NY), and a *P* value less than 0.05 was considered statistically significant.

Results

Baseline Characteristics

This study included a total of 1345 individuals, 423 of whom were men (31.4%) and 922 of whom were women (68.6%). The average participant age was 46.40 ± 18.33 years, and $12.15 \pm 8.52\%$ had exposure to patients with confirmed COVID-19. There were 140 patients (30.5%) with symptoms, 291 (21.6%) who wanted to be tested, and 664 (47.9%) for screening testing, respectively. Among the total participants, 7 (0.5%) tested positive (Table 1).

HCWs versus Non-HCWs

The chi-square test, *t*-test, and Fischer's exact test were used to compare the general characteristics and RT-PCR results of the two groups. The HCW group was young and had a low rate of underlying diseases ($P < 0.001$). In addition, there

Table 1 Baseline Characteristics of Total Study Population and the Two Groups of Subjects Divided by HCW and Non-HCW (Occupational Status)

	Total (n = 1345)	HCWs (n = 624, 47.4%)	Non-HCWs (n = 721, 52.6%)	P value
Age, y	46.40 ± 8.33	34.90 ± 10.51	56.36 ± 17.82	0.000
Sex				0.000
Male	423 (31.4%)	153 (24.5%)	270 (37.4%)	
Female	922 (68.6%)	471 (75.5%)	451 (62.6%)	
Exposure	227 (16.9%)	208 (33.3%)	19 (2.6%)	0.000
Purpose of examination				0.000
Exhibiting symptoms	410 (30.5%)	371 (59.5%)	39 (5.4%)	
Wanted	291 (21.6%)	241 (38.6%)	50 (6.9%)	
Screening	664 (47.9%)	12 (1.9%)	632 (87.7%)	
COVID-19 PCR (+)	7 (0.5%)	4 (0.6%)	3 (0.3%)	0.711*
Symptoms related to COVID-19	454 (33.8%)	389 (62.3%)	65 (9.0%)	<0.001
Fever	54 (4.0%)	43 (6.9%)	11 (1.5%)	<0.001
Sore throat	266 (19.8%)	245 (39.3%)	21 (2.9%)	<0.001
Cough	221 (16.4%)	202 (32.4%)	19 (2.6%)	<0.001
Sputum	140 (10.4%)	119 (19.1%)	21 (2.9%)	<0.001
Muscle pain	51 (3.8%)	48 (7.7%)	3 (0.4%)	<0.001
Rhinorrhea	40 (3.0%)	35 (5.6%)	5 (0.7%)	<0.001
Headache	22 (1.6%)	20 (3.2%)	2 (0.3%)	<0.001
Diarrhea	19 (1.4%)	17 (2.7%)	2 (0.3%)	<0.001
Others	115 (8.6%)	99 (15.9%)	15 (2.1%)	<0.001
Underlying diseases	355 (26.4%)	40 (6.4%)	315 (43.7%)	<0.001
Hypertension	175 (13.0%)	18 (2.9%)	157 (21.8%)	<0.001
Diabetes mellitus	105 (7.8%)	4 (0.6%)	101 (13.9%)	<0.001*
Dyslipidemia	77 (5.7%)	11 (1.8%)	66 (9.2%)	<0.001
Cardiovascular disease	51 (3.8%)	6 (1.0%)	45 (6.2%)	<0.001
Hepatobiliary disease	23 (1.7%)	3 (0.5%)	20 (2.8%)	0.001
Cerebrovascular disease	16 (1.2%)	1 (0.2%)	15 (2.1%)	0.001
Renal disease	34 (2.5%)	1 (0.2%)	33 (4.6%)	<0.001
Cancer	96 (7.1%)	6 (1.0%)	90 (12.5%)	<0.001
Thyroid disease	21 (1.6%)	4 (0.6%)	17 (2.4%)	0.011
Respiratory disease	17 (1.3%)	0 (0.0%)	17 (2.4%)	<0.001

Notes: Data are presented as mean ± standard deviation or number (%). *Fisher's exact test.

were more women, symptomatic individuals, and individuals with exposure to confirmed cases. There were many cases of testing in which subjects just wanted it or did it because of symptoms ($P < 0.001$). All symptoms were high in the HCW group, including sore throat (39.3%), cough (16.4%), sputum (10.4%), muscle pain (7.7%), and fever (4.0%) ($P < 0.001$).

The study participants were divided into HCWs and non-HCWs by date of visit. A remarkable number of HCWs tested positive during the first 2 weeks of operating the outpatient center, but the number rapidly decreased thereafter (Figure 2).

COVID-19 RT-PCR Positive vs Negative

The positive group had a high rate of exposure to confirmed COVID-19 patients ($P = 0.002$), and there were many subjects who just wanted to get tested or got tested because of symptoms. ($P = 0.005$). The number of participants who were symptomatic was not significantly different between the groups, but the incidence of fever and sore throat was high in the positive group ($P < 0.05$). There was no significant difference in the average age, employment status, and presence or absence of underlying diseases (Table 2).

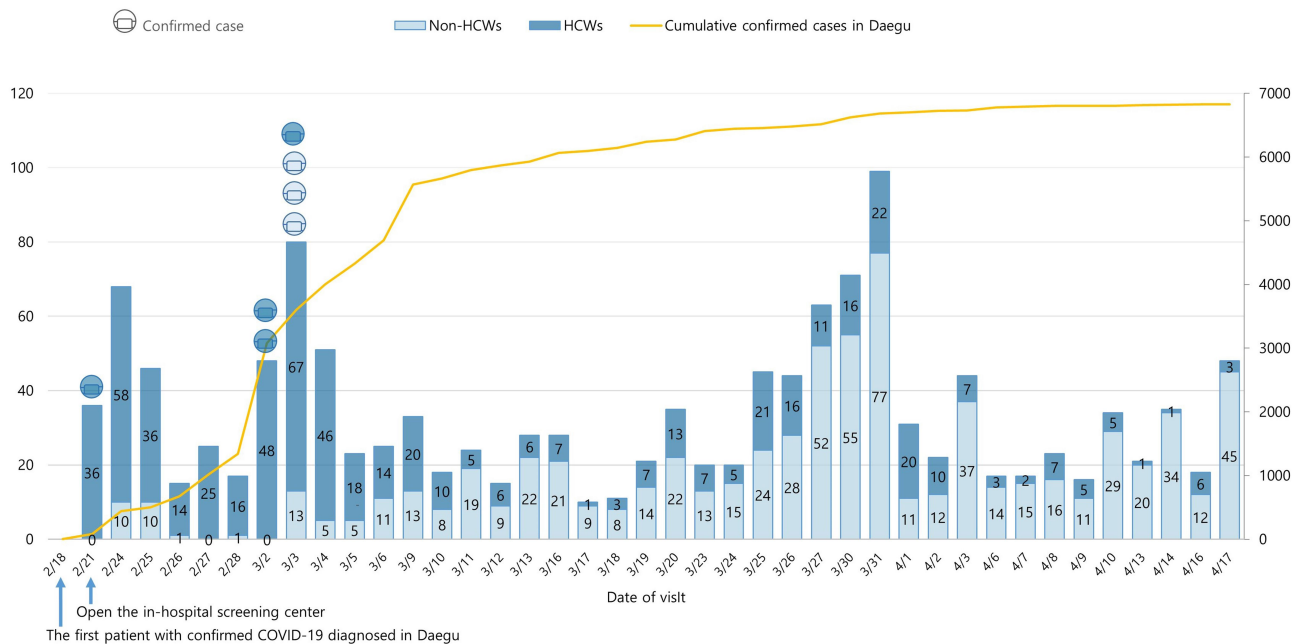


Figure 2 Number of HCWs and non-HCWs by date of visit.

COVID-19 Positive Cases

Four of the seven confirmed COVID-19 patients were HCWs, and three were caregivers in a ward that was exposed to the second and third confirmed COVID-19 patients (Table 3).

The first confirmed COVID-19 patient was a 24-year-old female nurse who worked in the nonrestricted area. She had symptoms of fever, sore throat, cough, and rhinorrhea from the morning of February 21. On the same afternoon, she visited the outpatient center and tested positive. She had no exposure to confirmed COVID-19 patients and no history of travel to a high risk area.

The second confirmed COVID-19 patient (33-year-old woman) and the third confirmed COVID-19 patient (23-year-old woman) were nurses working in the same ward as the first confirmed COVID-19 patient. The second patient had a sore throat and cough on February 29, and the third patient had a sore throat and cough on March 1. Both the second and third patients were tested at the outpatient center on March 2. The first, second, and third confirmed COVID-19 patients visited the in-hospital screening station after work, and then returned home to minimize the time and distance of their stay in the hospital after the examination. The patients did not return to the hospital until the test results were checked. After the results were positive, the infection control center notified the local public health center for follow-up.

The fourth patient with confirmed COVID-19 was a 49-year-old male hospital staff member who worked at the reception desk on the first floor of the hospital. He had a history of exposure to patients who were later confirmed to have COVID-19 later, as he spoke with them for approximately 5 minutes 10 days before his symptoms developed. On March 2, the patient had a sore throat and cough. He was tested on March 3.

Because there were two confirmed COVID-19 patients in the same ward, the possibility of transmission in the hospital was considered. Eleven guardians who were exposed to the second and third patients were tested in the outpatient center. The fifth, sixth, and seventh patients were asymptomatic, but were found positive by RT-PCR testing (27.3%).

Safety of the In-Hospital Screening Station

During the study period, there were no cases of secondary infection among HCWs who worked at the screening station, patients, or caregivers.

Correlation Between COVID-19 Suspected Symptoms and Participant Characteristics

In this study, a logistic regression analysis using the Enter method was performed with the presence of symptoms as dependent variables to analyze the variables in relation to the presence or absence of participants' suspected

Table 2 Baseline Characteristics of the Two Groups Divided by RT-PCR Result

	COVID-19 (+) (n = 7)	COVID-19 (-) (n = 1338)	P value*
Age, y	45.86 ± 19.15	46.40 ± 18.34	0.439 [†]
Sex			1.000
Male	2 (28.6%)	421 (31.55%)	
Female	5 (71.4%)	917 (68.5%)	
HCWs	4 (57.1%)	620 (46.3%)	0.711
Exposure	5 (71.4%)	222 (16.6%)	0.002
Purpose of examination			0.005
Exhibiting symptoms	3 (42.9%)	407 (30.4%)	
Wanted	4 (57.1%)	287 (21.4%)	
Screening	0 (0.0%)	644 (48.15%)	
Symptoms related to COVID-19	4 (57.1%)	450 (33.6%)	0.235
Fever	2 (28.6%)	52 (3.9%)	0.029
Sore throat	1 (57.1%)	262 (19.6%)	0.032
Cough	3 (42.9%)	218 (16.3%)	0.092
Sputum	0 (0.0%)	140 (10.5%)	1.000
Muscle pain	0 (0.0%)	51 (3.8%)	1.000
Rhinorrhea	1 (14.3%)	39 (2.9%)	0.191
Headache	0 (0.0%)	22 (1.6%)	1.000
Diarrhea	0 (0.0%)	19 (1.4%)	1.000
Others	0 (0.0%)	114 (8.5%)	1.000
Underlying diseases	0 (0.0%)	355 (26.5%)	0.200
Hypertension	0 (0.0%)	175 (13.1%)	0.604
Diabetes mellitus	0 (0.0%)	105 (7.9%)	1.000
Dyslipidemia	0 (0.0%)	77 (5.8%)	1.000
Cardiovascular diseases	0 (0.0%)	51 (3.8%)	1.000
Hepatobiliary disease	0 (0.0%)	23 (1.7%)	1.000
Cerebrovascular disease	0 (0.0%)	16 (1.2%)	1.000
Renal disease	0 (0.0%)	34 (2.5%)	1.000
Cancer	0 (0.0%)	76 (7.2%)	1.000
Thyroid disease	0 (0.0%)	21 (1.6%)	1.000
Respiratory disease	0 (0.0%)	17 (1.3%)	1.000

Notes: *Fisher's exact test. [†]Mann-Whitney U-test.

COVID-19 symptoms. The results of the analysis showed that the HCWs were significantly associated with the presence of symptoms, having an odds ratio (OR) of 23.317 (confidence interval [CI], 15.142–35.907; $P < 0.001$) (Table 4).

Discussion

A pandemic is a significant epidemic disease outbreak that can remarkably increase the incidence of disease and mortality across a large region and can trigger economic, social, and political crises. Therefore, international cooperation is needed, but preparedness and response plans may vary according to the conditions of each country.

Viruses that have historically caused pandemics, such as influenza virus, coronavirus, ebola virus, and zika virus, are RNA viruses, which are approximately 1000 times more susceptible to mutations than DNA viruses. Thus, it is difficult to create vaccines for the viruses, and the virus tends to settle itself after a sudden pandemic, making it difficult to secure enough time to develop and evaluate vaccines or suitable treatments.¹⁸ As with the current COVID-19 pandemic, infectious diseases without adequate vaccines and treatments should be investigated and analyzed, and various strategies should be explored to minimize the spread between infected and non-infected populations. In addition, to minimize interactions between

Table 3 Clinical Characteristics of Patients with Confirmed COVID-19

No.	Sex/Age	Status	Exposure	Symptom		Date of Examination	Underlying Diseases
				Date of Onset			
1	F/24	Nurse	–	02.21	F, ST, C, R	02.21	–
2	F/33	Nurse	–	02.29	ST, C	03.02	–
3	F/23	Nurse	+	03.01	ST, C	03.02	–
4	M/49	Others	+	03.02	ST, C	03.03	–
5	F/61	Caregiver	+	–	–	03.03	–
6	M/69	Caregiver	+	–	–	03.03	–
7	F/62	Caregiver	+	–	–	03.03	–

Abbreviations: C, cough; F, fever; R, rhinorrhea; ST, sore throat.

infected and non-infected populations, the movement of people without symptoms should be limited and the infectivity of patients with symptoms should be minimized using appropriate antiviral and antibiotic treatments. Moreover, social distancing, including closure of schools and travel restrictions, should be implemented. Personal protective measures, such as the use of masks and hand sanitizers, should also be recommended. Hence, the outcome after the epidemic of infectious diseases is determined not only by the diversity of pathogens as causative agents, but also by pathogen–human interactions. Even though there are various social, political, and economic factors in each country with regards to resources,

capabilities, and strategies for mitigation, the healthcare workforce is important in all.

HCWs are on the frontlines of epidemic control with limited personnel. They experience physical and mental distress caused by heavy workloads; lack of sleep; the high risk of infection for themselves and their loved ones; social isolation; and exposure to constantly changing situations that lead to stress, fear, and anxiety, resulting in a decrease in work ability and staffing issues.¹⁹ The reduced number of HCWs slows healthcare services and increases the fatigue of the remaining staff, leading to poor quality healthcare services as well as delays in diagnoses and treatments. Hence, patient mortality can increase, and infectious diseases can spread. Therefore, strategies to maintain healthcare personnel should be a priority.

Table 4 Logistic Regression Analysis Using Enter Method for COVID-19 Suspected Symptoms and Characteristics of Subjects

Independent Variables	Odds Ratio	95% Confidence Interval	P value
Employment status Non-employees Employees	1.000 23.317	15.142–35.907	<0.001
Age	1.003	0.992–1.015	0.568
Sex Male Female	1.000 1.027	0.75–1.404	0.866
Exposed to confirmed COVID-19 patients No Yes	1.000 0.719	0.512–1.010	0.057
Underlying disease No Yes	1.000 1.453	0.933–2.262	0.099

Previous studies in regards to the psychological impact of HCWs during the SARS and COVID-19 pandemic periods have reported that the incidence of symptoms, such as anxiety, depression, insomnia, and somatization, was high in HCWs, which was significantly different compared with non-HCWs.²⁰ Major risk factors included female sex and contact with patients with a confirmed infectious disease.^{9,20} In a meta-analysis for several viral outbreaks, including SARS, COVID-19, Middle East respiratory syndrome (MERS), Ebola virus disease, and influenza A virus subtype H1N1 (swine influenza), the risk of acute or post-traumatic stress (OR, 1.71; 95% CI, 1.28–2.29) and psychological distress (OR, 1.74; 95% CI, 1.50–2.03) increased. Women, younger individuals, and parents with dependent children were found to be especially vulnerable to psychological distress. These results were consistent with previous studies.²¹

The current study is the first to study the results of operating in-hospital screening station, unlike existing screening stations operated outside the hospital. The

study aimed to conveniently and efficiently identify the virus infection among HCWs, outpatients, and newly admitted patients at a local hospital in the Korean city where confirmed COVID-19 cases increased most rapidly during the COVID-19 pandemic. The rate of patients with symptoms in the HCW group was significantly higher than that of the non-HCW group at the in-hospital screening station. When analyzing the correlation between suspected COVID-19 symptoms and other variables, HCWs showed a significantly higher OR for the presence or absence of COVID-19 suspected symptoms. However, only 4 (1.08%) out of 371 cases with symptoms tested positive. This is owing to the psychological influence that the HCW group was relatively young and had high proportions of women and exposure to patients with confirmed COVID-19 during the chaotic early period of the COVID-19 pandemic, which is consistent with the results of a previous study. Such anxiety and depression are known to cause physical symptoms such as fatigue, headache, and muscle pain.²² In addition, laryngopharyngeal reflux symptoms, including cough, sore throat, and globus pharyngeus, may appear as a result of autonomic dysfunction, and are similar to the early symptoms of COVID-19.^{23,24} Thus, it is possible that the incidence of patients with symptoms was high because there were many symptoms similar to COVID-19 symptoms resulting from the influence of psychological factors.

There is also the possibility of an extended nocebo effect, which is defined as showing an adverse effect after exposure to external factors that are believed to have a negative impact on health.²⁵ In the early pandemic period, HCWs were at the highest risk of exposure to COVID-19 patients at work, as they lacked information and understanding on the virus and its prevention and management. Thus, it is possible that suspected COVID-19 symptoms appeared as a result of negative expectations.

According to previous studies on these psychological effects, concerns about infection and spreading to families and neighbors accounted for a large part. This safety concern appeared to be the largest factor hindering the willingness of HCWs to continue working during the pandemic period.^{9,26} Therefore, providing HCWs with reliable information about viruses and their prevention and management, as well as enhancing personnel safety perceptions, can help to reduce the psychological impact and increase their willingness to continue working. As in the case of the hospital in this study, operating in-hospital

screening station in a separate and independent area is an effective and safe method for relieving the psychological anxiety of HCWs and early screening of COVID-19 positive patients during the outbreak of infectious diseases. If a pandemic situation such as COVID-19 occurs in the future, operating such as center in advance and performing faster and safer testing are good ways to prevent the spread of infection in the hospital and to stop the spread at an early stage before informing the crisis of the infectious disease.

When the study participants were divided into HCWs and non-HCWs by date of visit, HCWs accounted for the majority of the visitors during the first 2 weeks of operating the in-hospital screening station. Of the 624 participants in the HCW group, 93 (14.9%) were asymptomatic HCWs who wore PPE in the isolation ward and were exposed to COVID-19 confirmed patients while taking care of them were. All of these HCWs tested negative. As the test results of HCWs' colleagues with similar exposure risks were found to be negative, it was believed that the number of HCWs visiting the screening station decreased sharply, likely because of reduced concerns about safety and the psychological effects and providing personnel safety perceptions.

In a previous meta-analysis, several studies showed that the risk of infection in HCWs differed by occupation during the influenza A (H1N1) pandemic period in 2009, but it was 2.08 times higher than that of non-HCWs.²⁷ Moreover, a number of HCWs in Europe were infected at the early stage of the Spanish flu pandemic, and there were a high number of HCW infections during the MERS epidemic in 2015.²⁸ If an HCW is infected, there is a risk of transmission to inpatients who are already vulnerable to systemic health problems and respiratory infections as well as a risk of disrupting the healthcare system because of the shutdown of an entire section.^{28,29} Thus, it is important to prevent the spread of infection by strengthening infection control in HCWs and healthcare institutions. In fact, infection of HCWs and infection through healthcare institutions were reported during the MERS epidemic in Korea.³⁰

A recent study showed that SARS-CoV-2 has high transmissibility owing to the short incubation period and spreads even among individuals without symptoms or those with mild symptoms.³¹ Accordingly, HCWs with mild symptoms or a history of contact with COVID-19 confirmed patients should undergo a screening test; other experts have also asserted this opinion.^{32,33}

There are various opinions on the effectiveness of in-hospital screening stations, particularly in terms of cost effectiveness. However, because political and economic situations vary by country, preparedness and response measures for pandemics are diverse, making it difficult to evaluate them comprehensively. Even though there are very few studies on the cost and cost effectiveness of such centers, it is most cost-effective to recognize diseases at an early stage and to block transmission by using available data.³⁴

In this study, the first patient who was tested positive for RT-PCR was in contact with a confirmed COVID-19 patient on the day before the test. The patients were all quarantined and tested negative with no risk of exposure to COVID-19. The second and third patients developed symptoms within 14 days after their last contact with the first patient, and their infections were considered transmission from the first patient because there were no other risk factors. The fifth, sixth, and seventh patients also tested positive at the asymptomatic stage at the in-hospital screening station after the second and third patients were tested positive, thereby blocking further infection in the hospital. The fourth patient was also infected at work by exposure to a confirmed COVID-19 patient before the patient was confirmed positive. Symptoms appeared 10 days after exposure, and the fourth patient was tested at the screening station the day after the symptoms developed. The confirmed COVID-19 patients in this study were tested within a few days after the onset of mild symptoms or during the asymptomatic stages after exposure, minimizing exposure to others. No secondary infection occurred. In addition, it was possible to block further in-hospital transmission and to prevent infected people entering the hospital by identifying the presence or absence of infection among new employees, patients who were referred to the screening station from a general outpatient department, or patients who were scheduled to be hospitalized in a nonrestricted area of the hospital.

The limitations of this study are as follows. First, this study was a retrospective study that did not directly investigate changes in influence of psychological factors, such as anxiety or depression in the participants. Second, the risk of exposure in accordance with the occupations of HCWs and psychological effects based on their family relationships may exist. However, the information was insufficient. Third, there may be a selection bias because the study targeted patients who visited the in-hospital screening station voluntarily or according to hospital

policy after developing symptoms or exposure to a confirmed COVID-19 patient.

Conclusion

This study is significant as it is the first study to evaluate the safety and effectiveness of an in-hospital COVID-19 screening station on an outpatient basis. We believe such centers are a relatively safe way to efficiently examine patients with possible infection, to protect and support HCWs, and to minimize and manage in-hospital transmission effectively, with limited resources, at a local hospital in Korea during a time of rampant epidemic of infectious disease. Large-scale studies with various approaches will be needed to evaluate the efficiency of such in-hospital screening stations in the future.

Author Contributions

Research design, data collection and analyses were completely performed by the authors. All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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